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**Small Arms Training**  
**Volume I, Pamphlet No. 6**  
**Supplement No. 1**

**The Anti-Aircraft Cartwheel Sight**  
**(Eye Shooting)**

For use with .300, .303 and .5-inch Weapons on A.A.  
Mountings and the 20-mm. Gun on the Universal  
Mounting Mark I.

**1943**

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## DISTRIBUTION

20 mm. A.A. coys. ...	Scale D
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Lt. A.A. " }	
S/L units	
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## SMALL ARMS TRAINING

Volume I, Pamphlet No. 6

THE ANTI-AIRCRAFT CARTWHEEL SIGHT  
(Eye Shooting)

## INTRODUCTION

1. The A.A. cartwheel sight is the standard sight for the engagement of low flying enemy aircraft with the 20 mm. gun on universal mounting, Mark I, and smaller calibre weapons on A.A. mountings (.300, .303, and .5).

2. The principles involved in the use of this sight are extremely simple.

3. The sight can be used so that effective fire can be brought to bear on aircraft attacking from any direction, at any speed, and at any angle of approach.

4. The sight enables the gunner to swing the gun on to the aircraft and apply the necessary lead with great rapidity. Speed is of extreme importance since the time of engagement using the 20 mm. and smaller calibre weapons will at all times be very short.

## DEFINITIONS

Throughout the instruction, certain terms are used which for convenience and ready reference are explained hereunder:—

1. **Line of sight.**—The straight line from the observer to the aircraft.

2. **Direction of flight.**—The prolongation of the fuselage in a forward direction. For practical purposes it can be taken as an imaginary line from the tail through the nose of the aircraft.

3. **Approach angle.**—The angle made by the direction of flight and the line of sight. This can be assessed by the appearance view of the aircraft or that proportion of the total length of the fuselage that appears to be visible.

4. **Aim-off.**—The amount it is necessary to lay the gun ahead of the aircraft to allow for travel of the aircraft during the time of flight of the projectile.

5. **Aim-off speed.**—The speed at which an aircraft crosses the line of sight.



6. **Crossing point.**—The position at which the aircraft is at its point of nearest approach to the gun.

7. **Present position.**—The position of the aircraft at the moment that the gun fires.

8. **Future position.**—The position at which the projectile and the aircraft meet, *i.e.*, the time of flight of the aircraft from the present to the future position must be the same as the time of flight of the projectile from the gun to the future position.

## CHAPTER I

### 1. Principles

1. **General.**—There is nothing new or difficult in shooting at aircraft using the A.A. cartwheel sight. The principle is the same as, say, throwing a boot at a cat running along the top of a wall. In order to allow for the travel of the cat during the time of flight of the missile it is necessary to aim at a point ahead of the target along its future direction. This is called "aim-off" (Fig. 1).

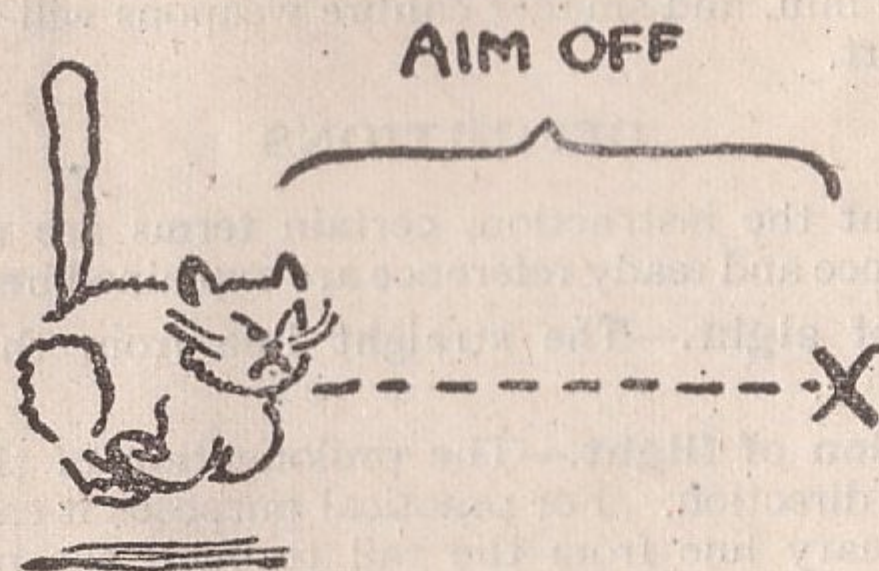


FIG. 1.

2. The *direction* and *amount* of aim-off and their application to the sight are arrived at in the following manner:—

#### (a) *Direction of aim-off*

With modern aircraft it can be assumed that the direction in which the fuselage of the aircraft is pointing is the direction of aim-off (Fig. 2).

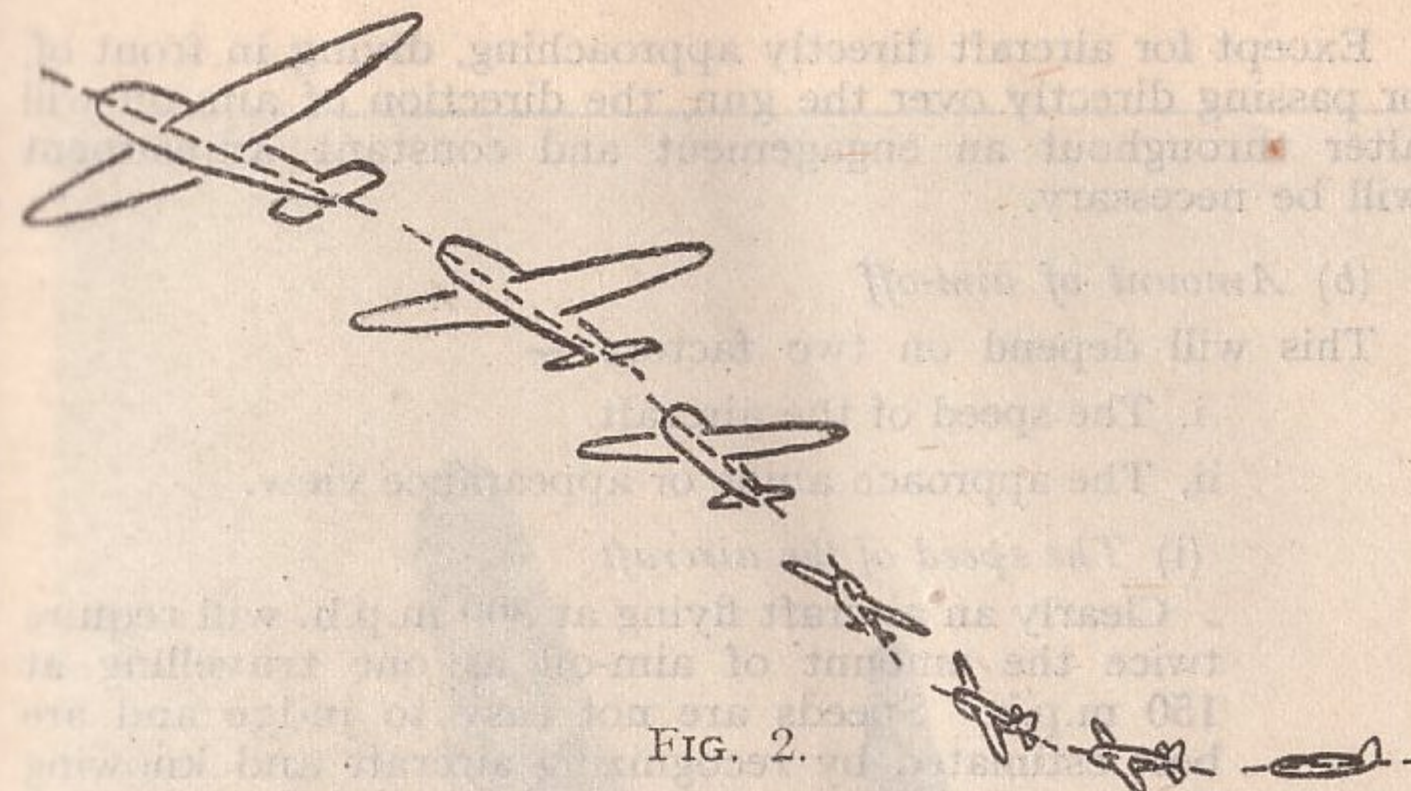


FIG. 2.

In order to apply this direction to the A.A. cartwheel sight the aircraft must be positioned in such a way that the fuselage appears always to point towards the centre of the sight. (Fig. 3).

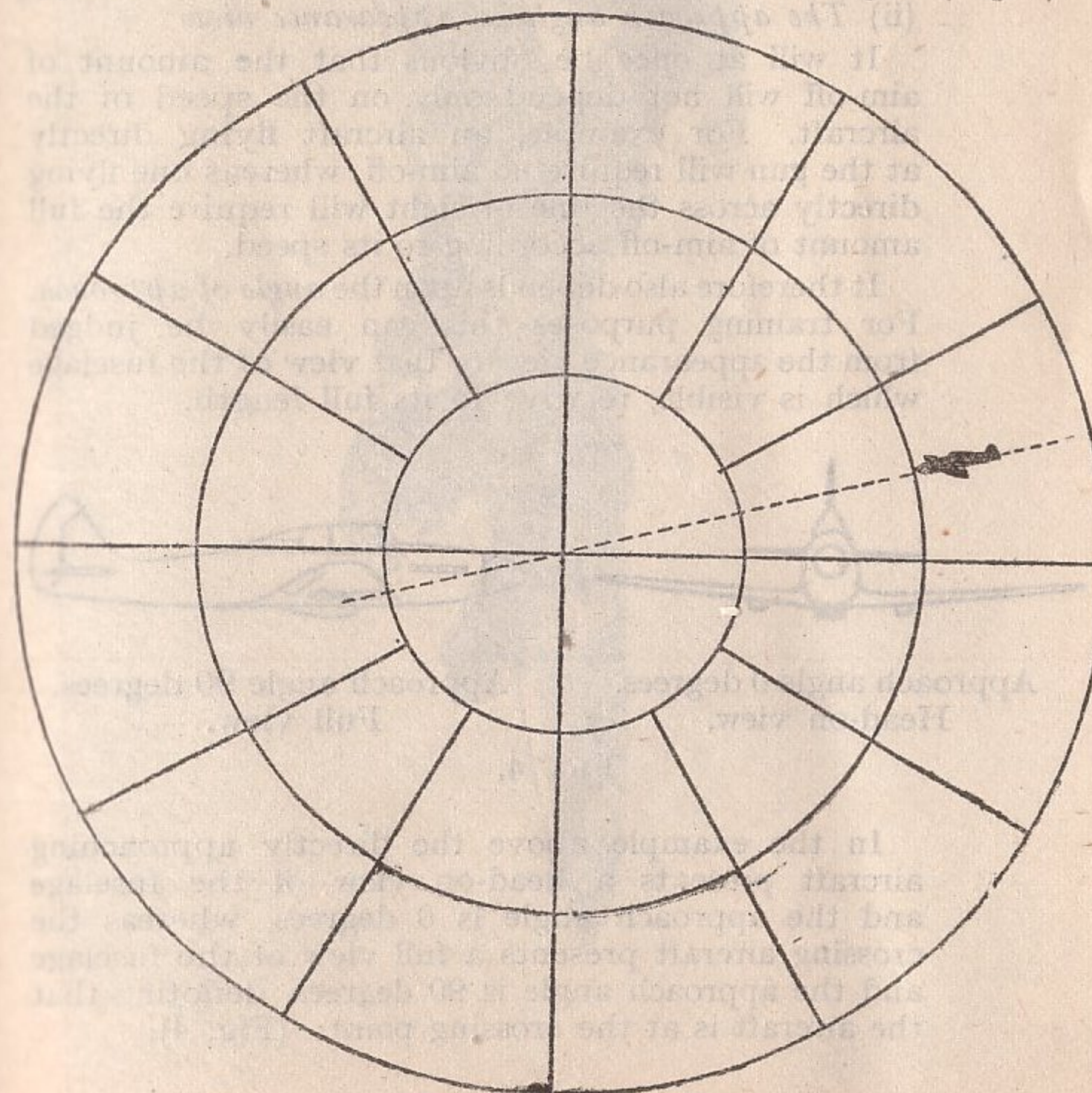


FIG. 3.



Except for aircraft directly approaching, diving in front of, or passing directly over the gun, the direction of aim-off will alter throughout an engagement and constant adjustment will be necessary.

(b) *Amount of aim-off*

This will depend on two factors:—

- i. The speed of the aircraft.
- ii. The approach angle or appearance view.

(i) *The speed of the aircraft*

Clearly an aircraft flying at 300 m.p.h. will require twice the amount of aim-off as one travelling at 150 m.p.h. Speeds are not easy to judge and are best estimated by recognizing aircraft and knowing their operational speeds. As a guide they can be separated into three groups of 100, 200, and 300 m.p.h., and these must at all times be known.

(ii) *The approach angle or appearance view*

It will at once be obvious that the amount of aim-off will not depend only on the speed of the aircraft. For example, an aircraft flying directly at the gun will require no aim-off, whereas one flying directly across the line of sight will require the full amount of aim-off according to its speed.

It therefore also depends upon the *angle of approach*. For training purposes this can easily be judged from the appearance view or that view of the fuselage which is visible, relative to its full length.



Approach angle 0 degrees.  
Head-on view.



Approach angle 90 degrees.  
Full view.

FIG. 4.

In the example above the directly approaching aircraft presents a head-on view of the fuselage and the approach angle is 0 degrees, whereas the crossing aircraft presents a full view of the fuselage and the approach angle is 90 degrees, denoting that the aircraft is at the crossing point. (Fig. 4).



FIG. 5.—He. 111. 30 degree approach angle or half appearance view.





Fig. 6.—Ju. 52. 60 degree approach angle or nearly full appearance view.

It will be impossible to judge approach angles or appearance views to fine limits, so that for practical purposes they are divided into five categories :—

<i>Approach angle</i>	<i>Appearance view</i>
About 0 degrees ...	Head-on.
„ 15 degrees ...	$\frac{1}{4}$ view.
„ 30 degrees ...	Coming up to $\frac{1}{2}$ view.
„ 60 degrees ...	Nearly full view.
„ 90 degrees ...	Full view.

### 3. Approach angle and aim-off speed

It will now be apparent that the amount of aim-off depends not only upon the speed of the aircraft but also upon its approach angle or appearance view, and according to the size of either, a proportion of the speed will be required. This is called *aim-off speed*.

Thus for small approach angles or when only a small amount of the fuselage appears to be visible the aim-off speed will be a fraction of the speed of the aircraft.

The aim-off speed, however, does not increase uniformly as the approach angle increases. When the angle is small, up to 30 degrees or half appearance view, a little increase in the angle will produce a large change in the aim-off speed, whereas near the crossing point when the approach angle is large the relative change in aim-off speed is small.

In order to arrive at the aim-off speed for different approach angles and different appearance views, the five categories given in paragraph 2 (b) (ii) are used in the following manner :—

<i>Approach angle</i>	<i>Appearance view</i>	<i>Aim-off speed</i>
About 0 degrees	Head-on view.	Nil.
„ 15 degrees	Quarter view.	Quarter aircraft speed.
„ 30 degrees	Coming up to half view.	Half aircraft speed.
„ 60 degrees	Almost full view.	Full aircraft speed, less 50 m.p.h.
90 degrees	Full view.	Full aircraft speed.

(For aircraft speeds see Appendix “B”.)



The aim-off speed is applied to the A.A. cartwheel sight by means of aim-off speed rings. (Fig. 7).

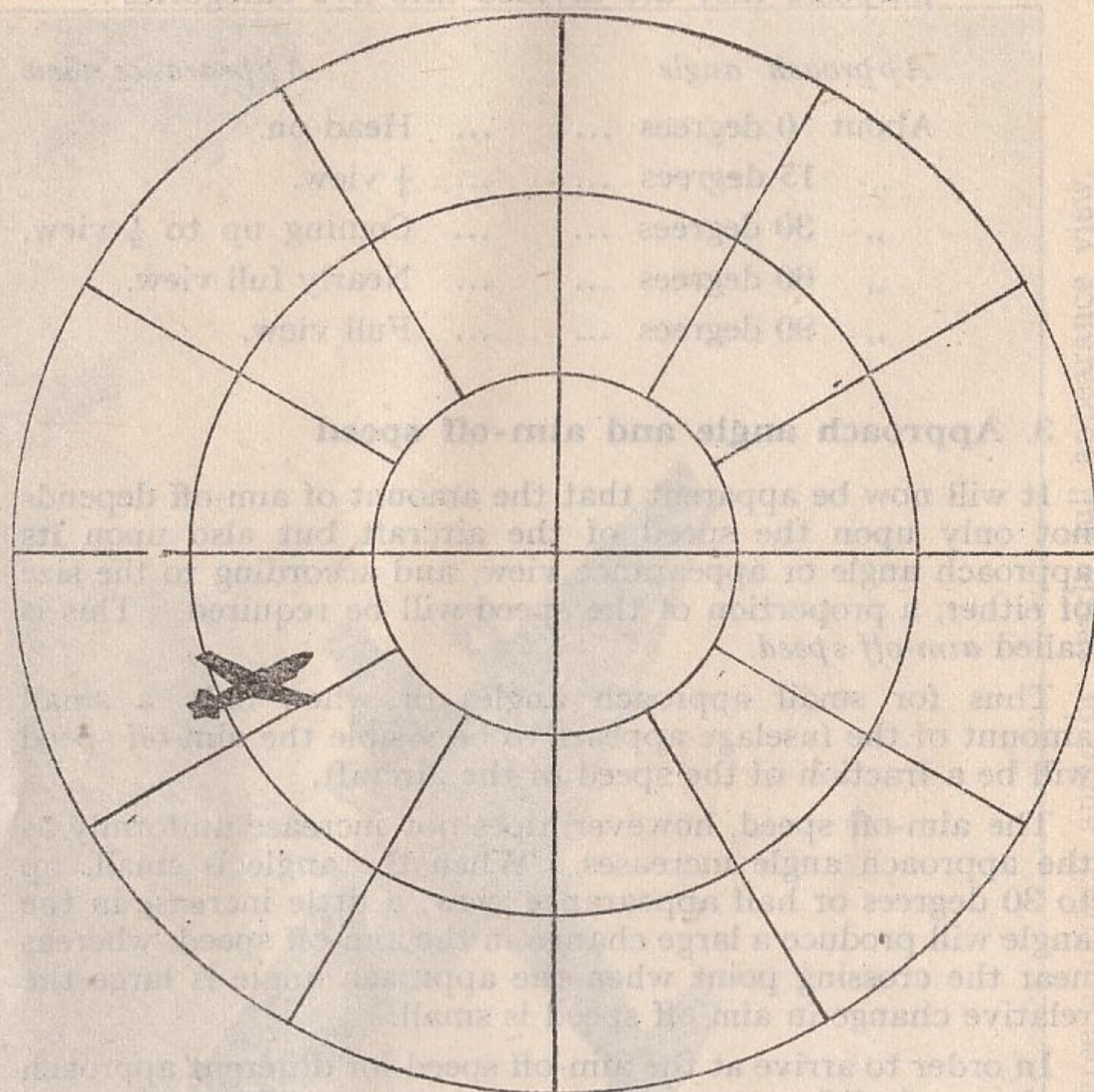


FIG. 7.—Me. 109E. 30 degrees approach angle or half appearance view equals 150 aim-off speed.

It must be remembered that while the approach angle or appearance view may be used as an aid during training, in practice, when an aircraft is spotted, it is the aim-off speed that must be judged instinctively and instantaneously without any thought of these aids.

## 2. The A.A. Cartwheel sight

The sight consists of two parts fixed on a common bar :—

- (a) An aperture backsight 1 in. in diameter with an X wire. A rubber eye-piece is provided which is used under certain conditions of fire control. (See Sec. 4, para. 8 (b)).

- (b) A cartwheel foresight comprising three concentric rings and a vertical and horizontal wire. The outside ring forms the frame and is approximately 6 ins. in diameter. The rings provide a scale for applying the aim-off speed to the sight and are known as aim-off speed rings. The outside ring is the 300 m.p.h. aim-off speed ring and the two inner rings are the 200 and 100 m.p.h. rings respectively. For aim-off speeds other than the exact figures of 100, 200 and 300 m.p.h. it is necessary to judge the correct position between the rings. In order to assist the gunner to apply the direction of aim off, eight radial wires are provided which radiate from the 100 m.p.h. ring to the outside frame.

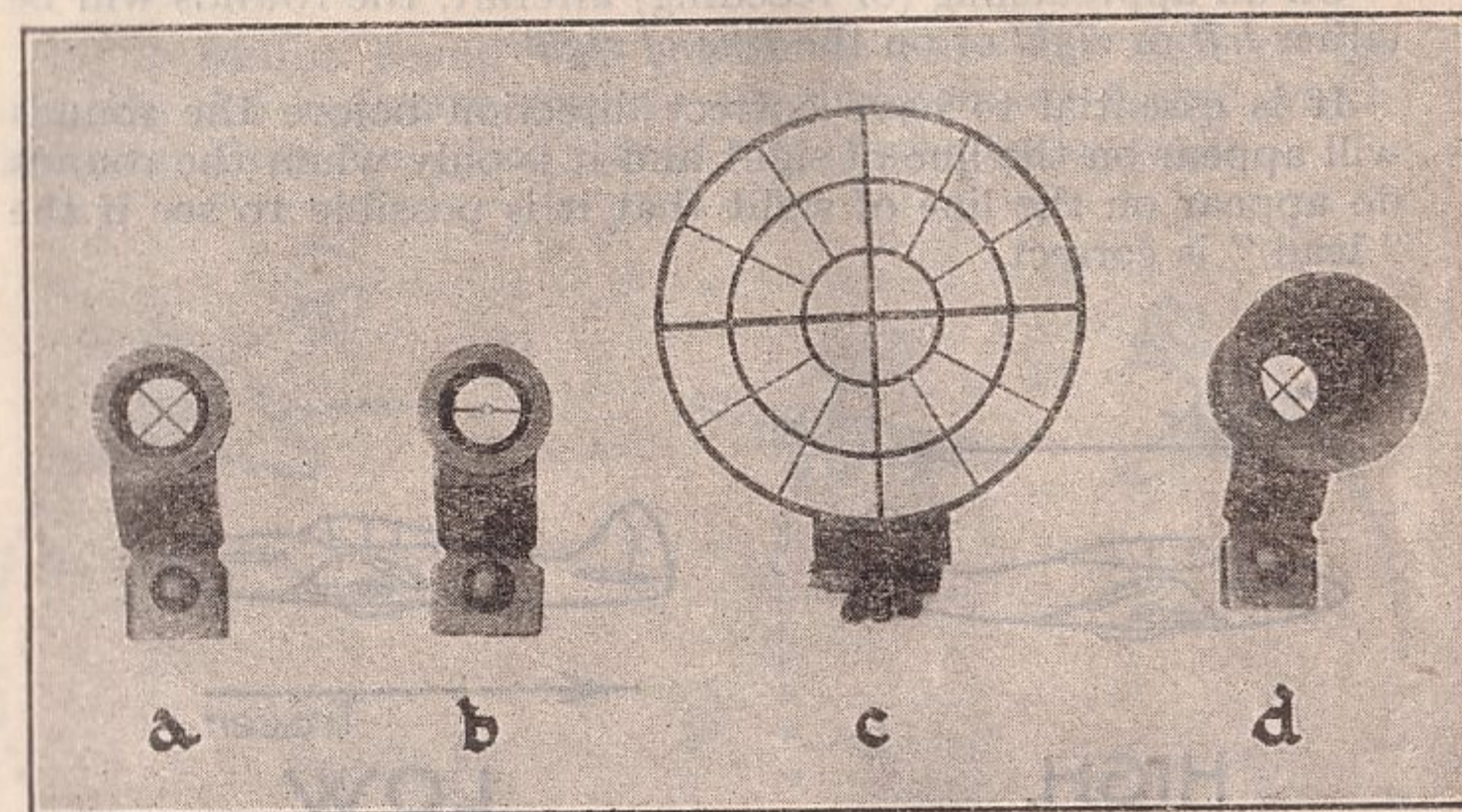


FIG. 8

- (a) Aperture backsight without rubber eye-piece.
- (b) Alternative to (a) if preferred.
- (c) Cartwheel sight.
- (d) Aperture backsight with rubber eye-piece.

## 3. Observation of tracer

1. In order that fire can be corrected by observation, it is essential to understand the appearance of the tracer.

Tracer is provided at extra expenditure of man hours of manufacture, and with 20 mm. H.E. ammunition, results in reduction of the bursting charge. It must, therefore, be used to the best advantage.



2. The great secret of tracer observation is to focus the eye on the target and not to follow the tracer stream from the gun.

Irrespective of the weapon, once fire is opened ignore the sight and focus the eyes on the target so that the tracer can be observed in the same way as laid down in S.A.T., Vol. I, Pamphlet No. 6 (1942), Section 10, "Hosepipe Firing."

The sights of the 20 mm. gun and of smaller calibre weapons are mounted well above the axis of the barrel so as to avoid any tendency on the part of the gunner to follow the tracer stream from the gun.

3. On a crossing aircraft the rounds will appear either *high* or *low* or on the *line of sight*.

On an approaching (or receding) aircraft, the rounds will be either *left* or *right* or on the *line of sight*.

It is essential to have correct direction before the rounds will appear on the line of sight and it is only when the rounds do appear on the line of sight that it is possible to see if the "lead" is correct.

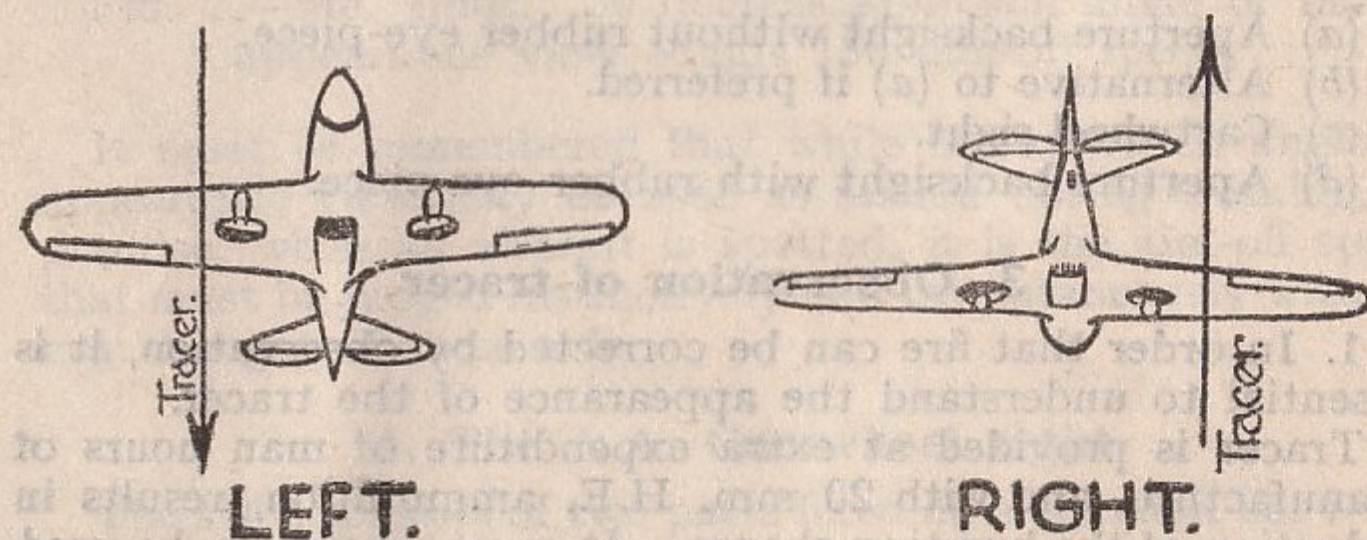
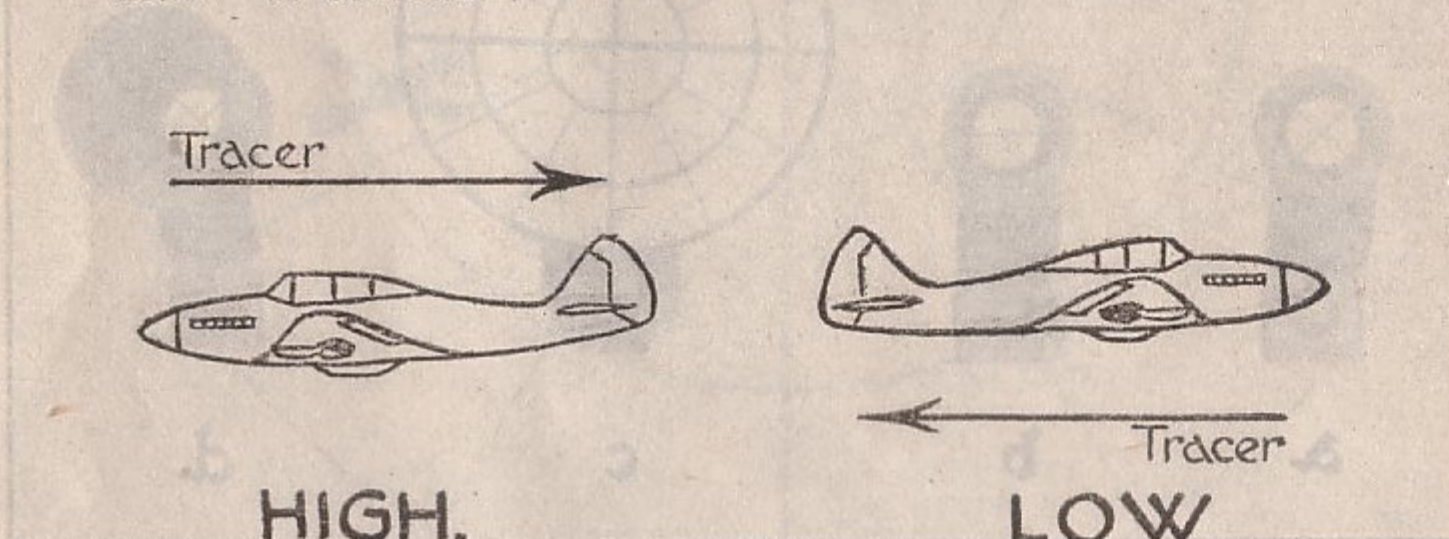


FIG. 9

## 5. Line of sight rounds

(a) Once direction is correct the rounds will appear on the *line of sight*.

(b) Line of sight rounds are either—*hit*, *plus*, or *minus* (Fig. 10).

(c) A hit is easy to observe using 20 mm. H.E. ammunition, but using S.A.A. or 20 mm. A.P. it is difficult to distinguish a hit from a minus.

(d) A plus round will appear to be momentarily obscured by the aircraft and indicates that the "lead" is at the moment too large.

(e) A minus round will appear to cross the face of the aircraft the opposite way to its direction of flight, which indicates that the "lead" is at the moment too small.

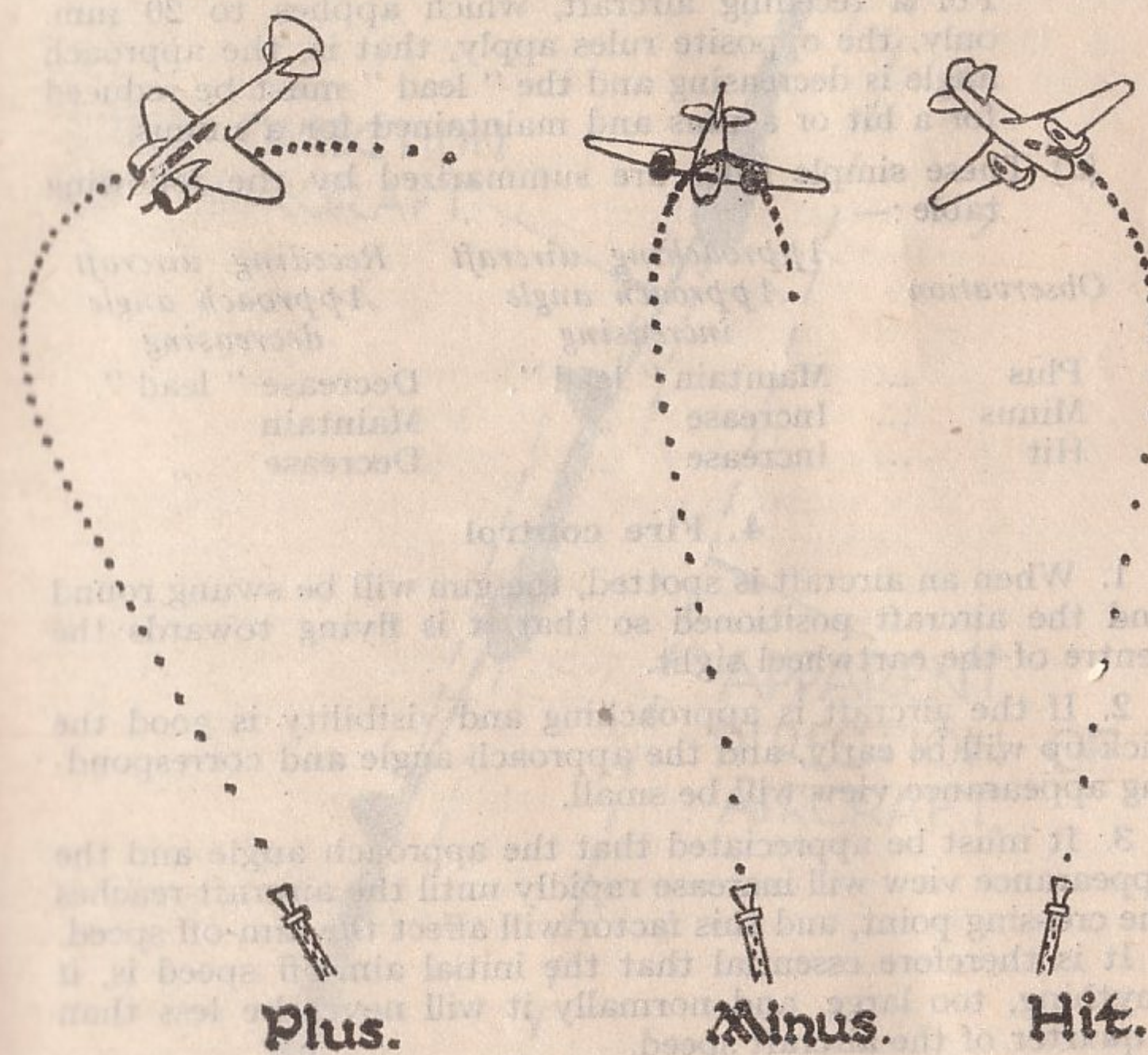


FIG. 10.



## 6. How to deal with line of sight rounds

For an approaching aircraft the approach angle or appearance view and the "lead" required will increase to the crossing point. Therefore :—

- (a) A *hit* will indicate that the "lead" is at the moment correct, but since the approach angle is increasing, it will soon be too small. The "lead" must therefore be increased.
- (b) A *plus* indicates that the "lead" is at the moment too large, but since the approach angle is increasing, it will become correct. Therefore the "lead" which is applied should be maintained.
- (c) A *minus* indicates that the "lead" is at the moment too small, and since the approach angle is increasing, the rounds will soon become more minus. The "lead" must be increased *boldly*. It is a crime for rounds to appear minus on an approaching aircraft. For a receding aircraft, which applies to 20 mm. only, the opposite rules apply, that is, the approach angle is decreasing and the "lead" must be reduced for a hit or a plus and maintained for a minus.

- (d) These simple rules are summarized by the following table :—

Observation	Approaching aircraft		Receding aircraft	
	Approach angle increasing		Approach angle decreasing	
Plus	...	Maintain "lead".	Decrease "lead".	
Minus	...	Increase "	Maintain "	
Hit	...	Increase "	Decrease "	

## 4. Fire control

1. When an aircraft is spotted, the gun will be swung round and the aircraft positioned so that it is flying towards the centre of the cartwheel sight.

2. If the aircraft is approaching and visibility is good the pick up will be early, and the approach angle and corresponding appearance view will be small.

3. It must be appreciated that the approach angle and the appearance view will increase rapidly until the aircraft reaches the crossing point, and this factor will affect the aim-off speed.

It is therefore essential that the initial aim-off speed is, if anything, too large, and normally it will never be less than a quarter of the aircraft speed.

Thus supposing an approaching aircraft to be in the 200 m.p.h. group— $\frac{1}{4}$  of 200 is 50—the aircraft must be

TRUE DIRECTION  
OF AIRCRAFT.

APPARENT  
DIRECTION OF  
AIRCRAFT.

FIG. 11



positioned half way between the centre of the sight and the 100 m.p.h. aim-off speed ring.

4. Once the target is correctly positioned the gunner must swing the gun at a rate equal to that of the aircraft, at the same time increasing the aim-off speed. When the aircraft reaches the crossing point the full amount of aim-off speed will be required.

5. With fast targets the time of engagement will be in the region of 4-5 seconds and continuous fire will be maintained during the attack, irrespective of the weapon used.

6. Fire will not be opened with the 20 mm. at ranges over 1,000 yards. With smaller calibre weapons the range will not exceed 600 yards.

7. Under normal conditions receding aircraft will not be engaged by weapons of smaller calibre than 20 mm. The increased range of the 20 mm. allows such aircraft to be engaged, but every effort must be made to destroy them before they reach the crossing point.

8. The method of using the sights on the 20 mm. gun and smaller calibre weapons is as follows:—

(a) *Using tracer*

The rubber eye-piece will not be fitted. The gunner will obtain his initial aim by looking through the aperture backsight, but once fire is opened he will ignore the sights and observe the tracer on the aircraft (i.e. Hosepipe).

Correction will be carried out as already explained in Sec. 3—Observation of Tracer.

(b) *Without tracer, or when tracer cannot be seen.*

The rubber eye-piece will be fitted to the aperture backsight.

The A.A. cartwheel sight will be used throughout the engagement, the gunner's eye being pressed firmly into the rubber eye-piece. The correct direction and aim-off speed will be obtained by means of the cartwheel sight.

### 5. Dive-bombing

1. In dealing with this type of target a small allowance has to be made if the aircraft is diving steeply, i.e. over 30 degrees. This allowance is most important since if it is not made the target will be missed.

2. Fig. 11 shows diagrammatically how, in a steep dive, the force known as "lift" has the effect of drawing the aircraft forward with the result that its true direction of flight is above its apparent direction of flight.

3. To counteract "lift" an allowance of 30 m.p.h. aim off speed will be made. If the aircraft is diving "short" of the gun position this allowance will be deducted from the aim-off speed. Should it be diving at or "over" the gun position, it will be added to the aim-off speed.

4. A dive-bomber attacking a gun position may approach in one of the following ways:—

(a) *Diving directly at the gun position*—a "head-on" view. (See Fig. 12.)

(b) *Diving over.* In this case the gunner will see more of the underside of the fuselage than in a "head-on" view, and there will be a definite "up" appearance view. (See Fig. 13.)

(c) *Diving short.* In this case the gunner will see rather more of the top of the fuselage than in a "head-on" view. (See Fig. 14.)

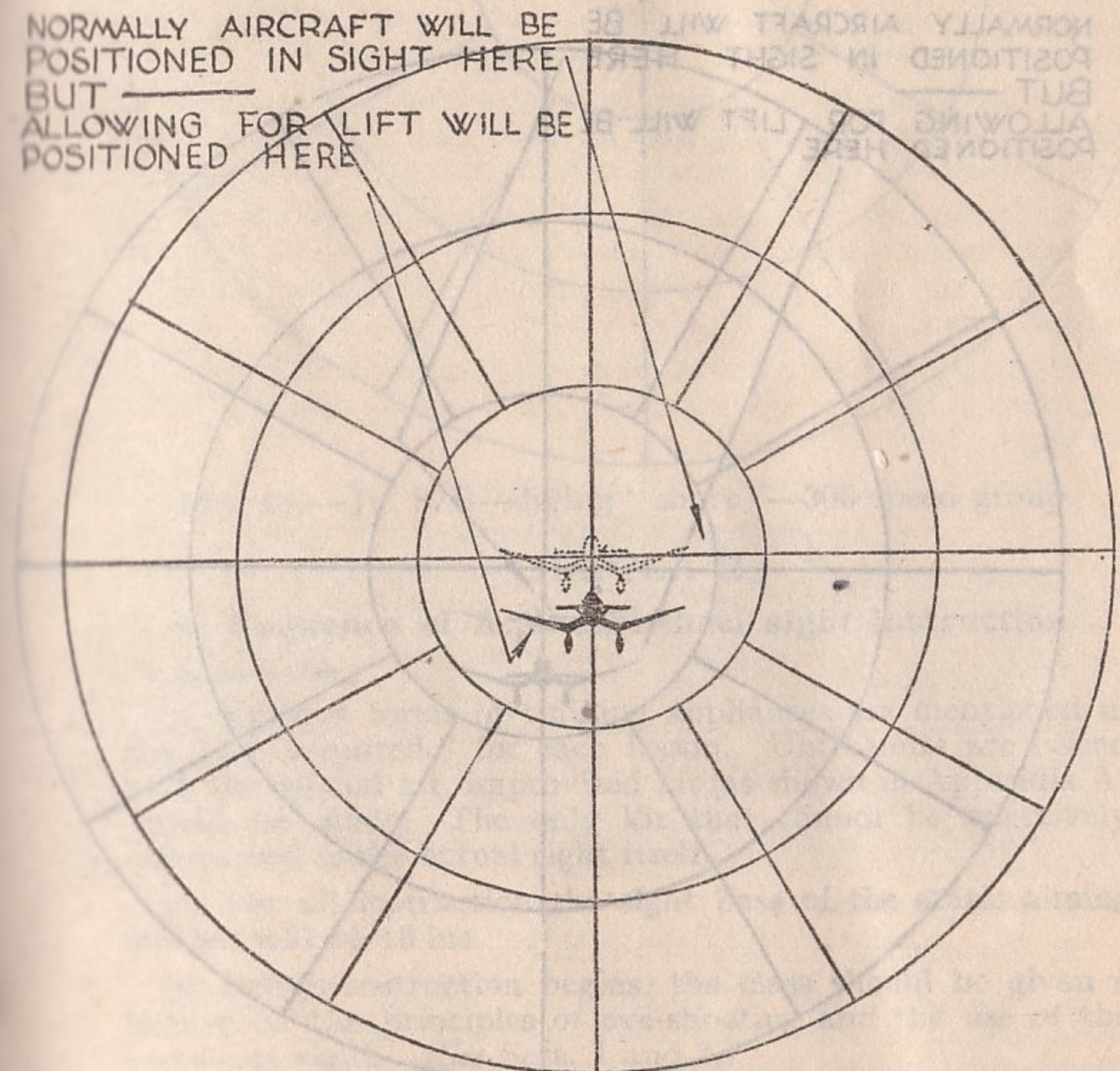


FIG. 12.—Ju. 87B—diving "head-on"—300 speed group.



The "drift" of the target against a cloud background (if such is available) is a most useful and practical guide to determine whether the aircraft is diving "head-on" "short," or "over." If the aircraft is diving "short," the cloud background will appear to be rising behind it. If diving "over" the cloud background will give the opposite impression. If neither of these obtain, the target will be diving directly "head-on."

5. Figs. 12, 13 and 14 illustrate the method of applying this extra allowance for the Ju. 87B. The position of the tail plane in relation to the fuselage should be noted, since it is a useful guide in the case of this aircraft:—

- (a) "Head-on"—Tail plane about halfway up fuselage.
- (b) "Diving over"—Tail plane only just visible.
- (c) "Diving short"—Tail plane high up on fuselage.

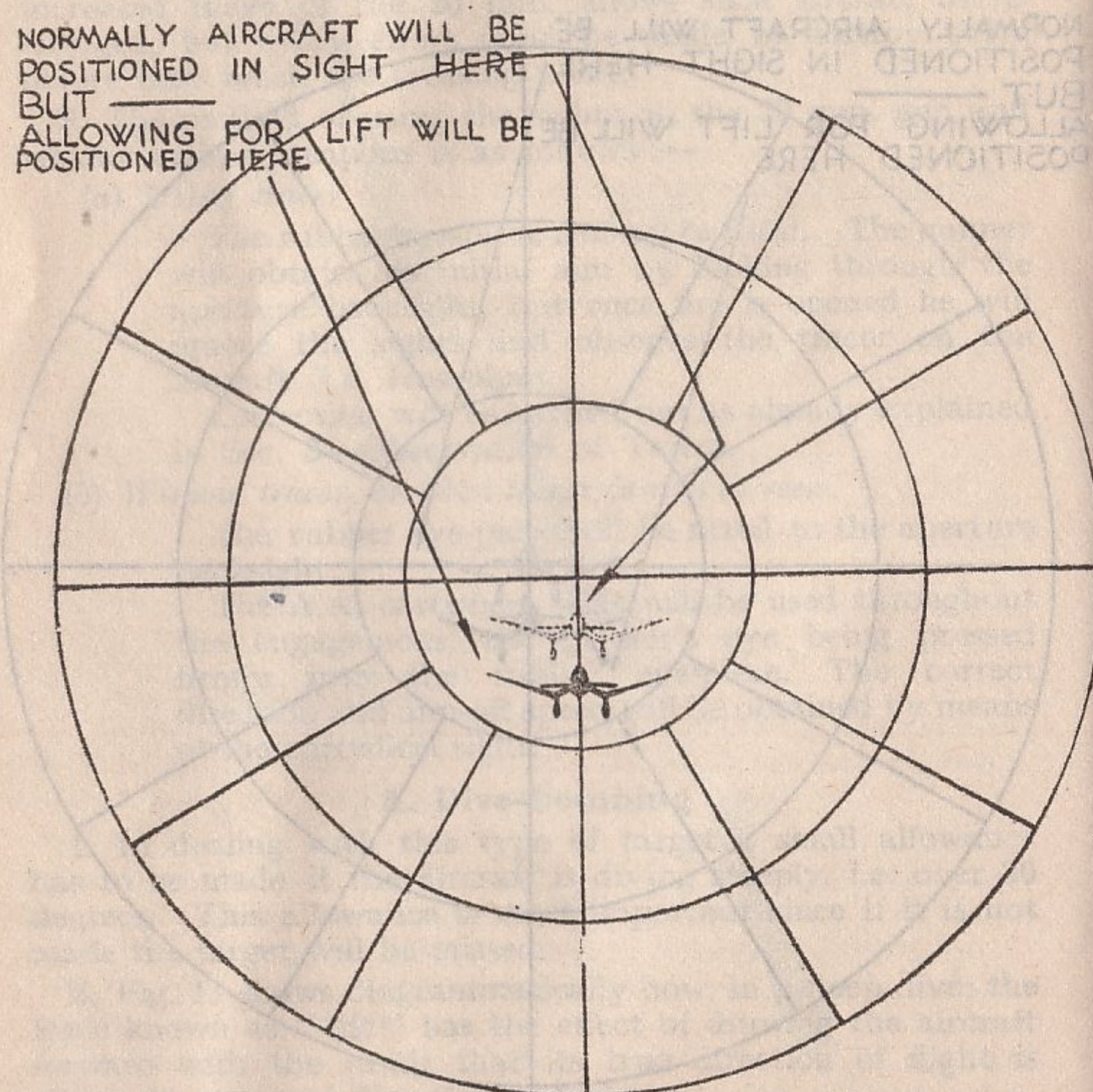


FIG. 13.—Ju. 87B—diving "over"—300 speed group.

NORMALLY AIRCRAFT WILL BE POSITIONED IN SIGHT HERE BUT ——— ALLOWING FOR LIFT WILL BE POSITIONED HERE.

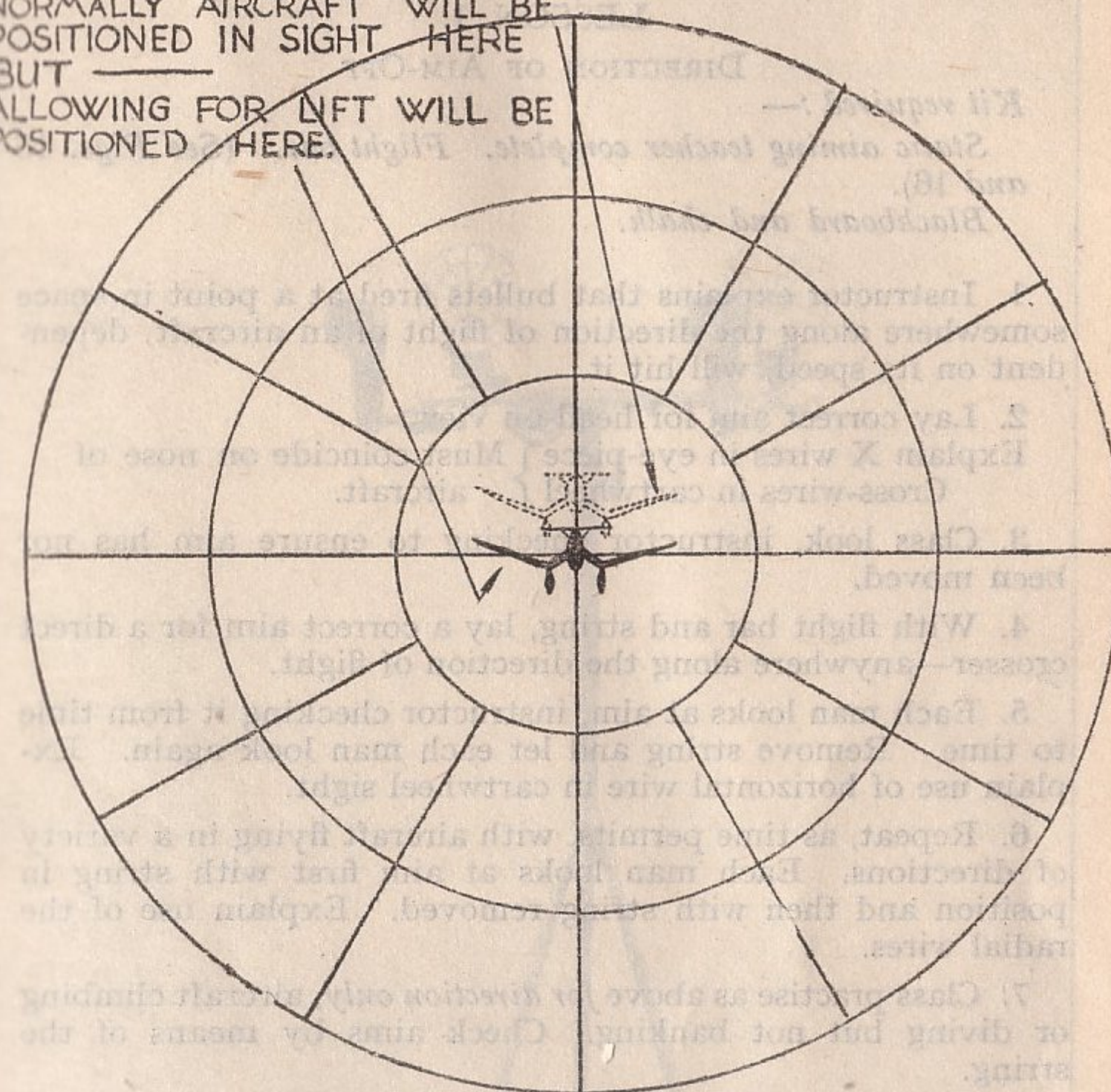


FIG. 14.—Ju. 87B—diving "short"—300 speed group.

## CHAPTER II

### 6. Sequence of A.A. cartwheel sight instruction

#### General notes:

(a) Various forms of training appliances are mentioned in the "kit required" for each lesson. Until units are issued with the official kit, improvised kit (as shown in Appendix A) should be made. The only kit that cannot be effectively improvised is the actual sight itself.

(b) For all instruction the sight base of the static aiming teacher will be 18 ins.

(c) Before instruction begins, the class should be given a lecture on the principles of eye-shooting and the use of the cartwheel sight. (See Secs. 1 and 2.)



## LESSON 1.

## DIRECTION OF AIM-OFF

*Kit required :—*

*Static aiming teacher complete. Flight bar. (See Figs. 15 and 16).*

*Blackboard and chalk.*

1. Instructor explains that bullets fired at a point in space somewhere along the direction of flight of an aircraft, dependent on its speed, will hit it.

2. Lay correct aim for head-on view.

Explain X wires in eye-piece } Must coincide on nose of  
Cross-wires in cartwheel } aircraft.

3. Class look, instructor checking to ensure aim has not been moved.

4. With flight bar and string, lay a correct aim for a direct crosser—anywhere along the direction of flight.

5. Each man looks at aim, instructor checking it from time to time. Remove string and let each man look again. Explain use of horizontal wire in cartwheel sight.

6. Repeat, as time permits, with aircraft flying in a variety of directions. Each man looks at aim first with string in position and then with string removed. Explain use of the radial wires.

7. Class practise as above *for direction only*, aircraft climbing or diving but not banking. Check aims by means of the string.

NOTES.—(a) Keep aircraft on an even keel.

(b) Do not mention anything about speeds.

## LESSON 2.

## ESTIMATION AND APPLICATION OF AIM-OFF

*Kit required :—*

*Static aiming teacher complete.*

*Flight bar.*

*Blackboard and chalk.*

1. Recapitulate.

2. Explain kit (for instructors only).

3. Instructor lays a correct aim for an aircraft at a 90-degree approach angle or full appearance view, at 200 m.p.h. Aircraft will be on a level keel. No flight bar or string.

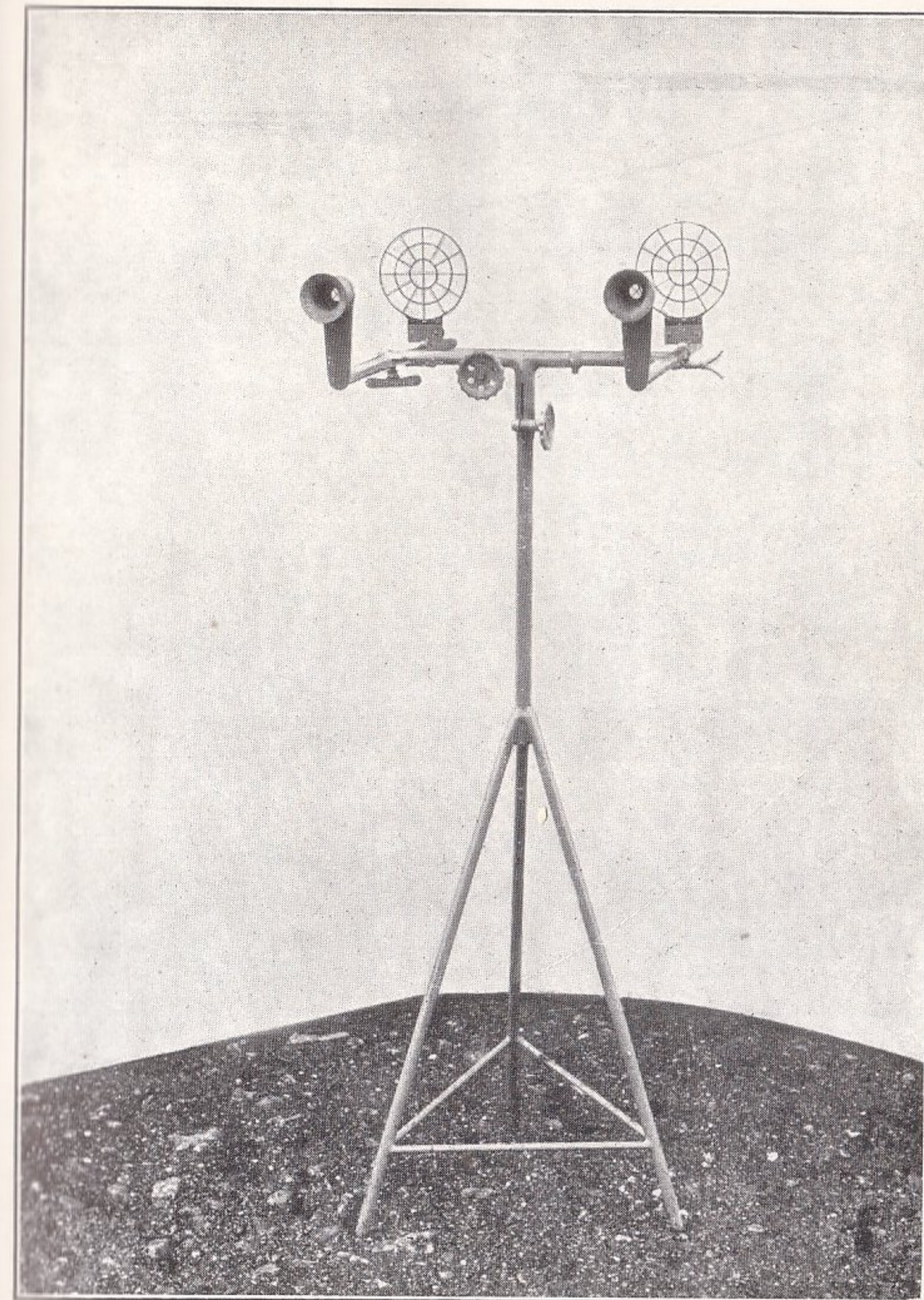


FIG. 15.—Static aiming teacher (sight end).  
To be issued to schools of instruction only.



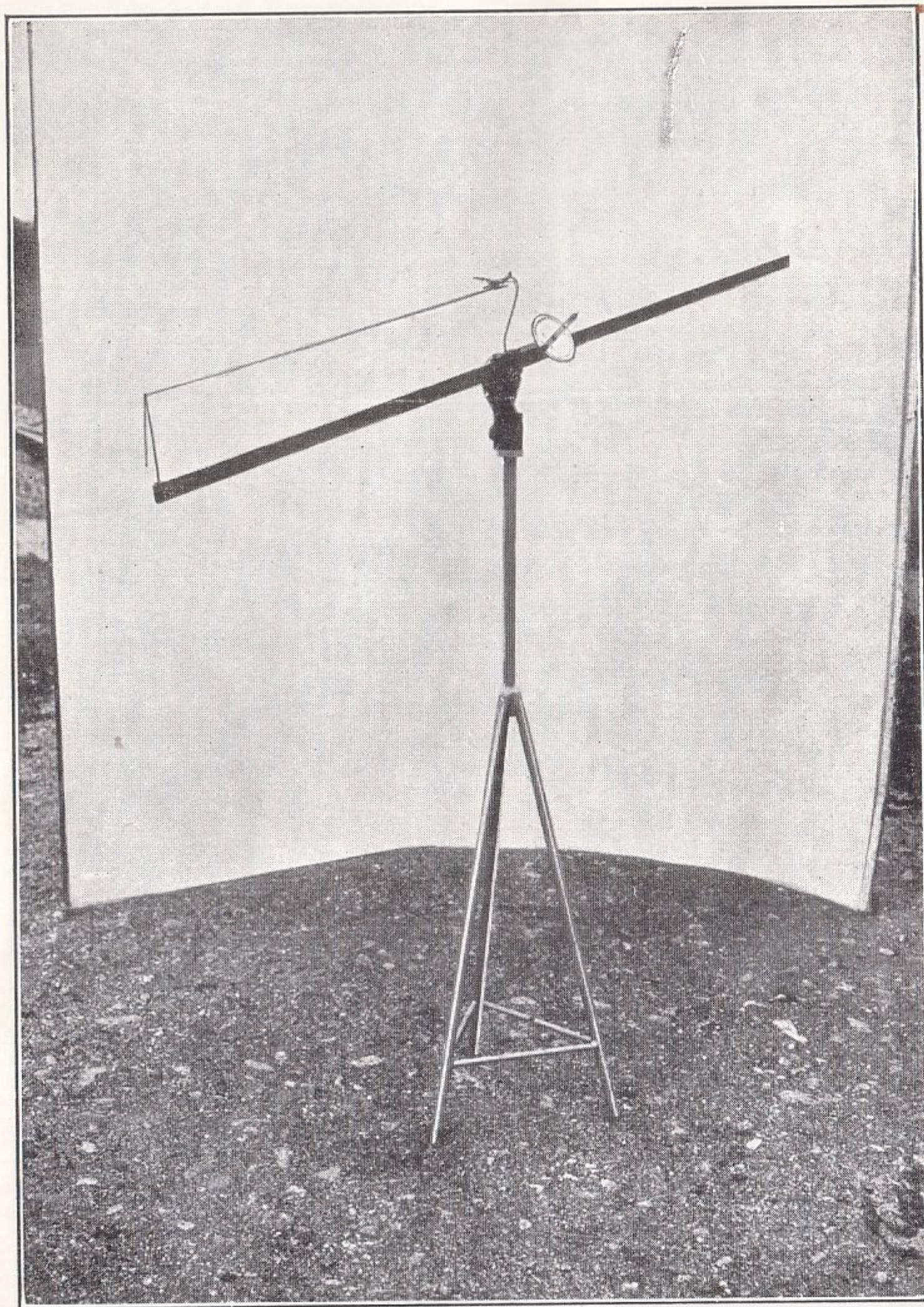


FIG. 16.—Static aiming teacher (target end).  
To be issued to schools of instruction only.

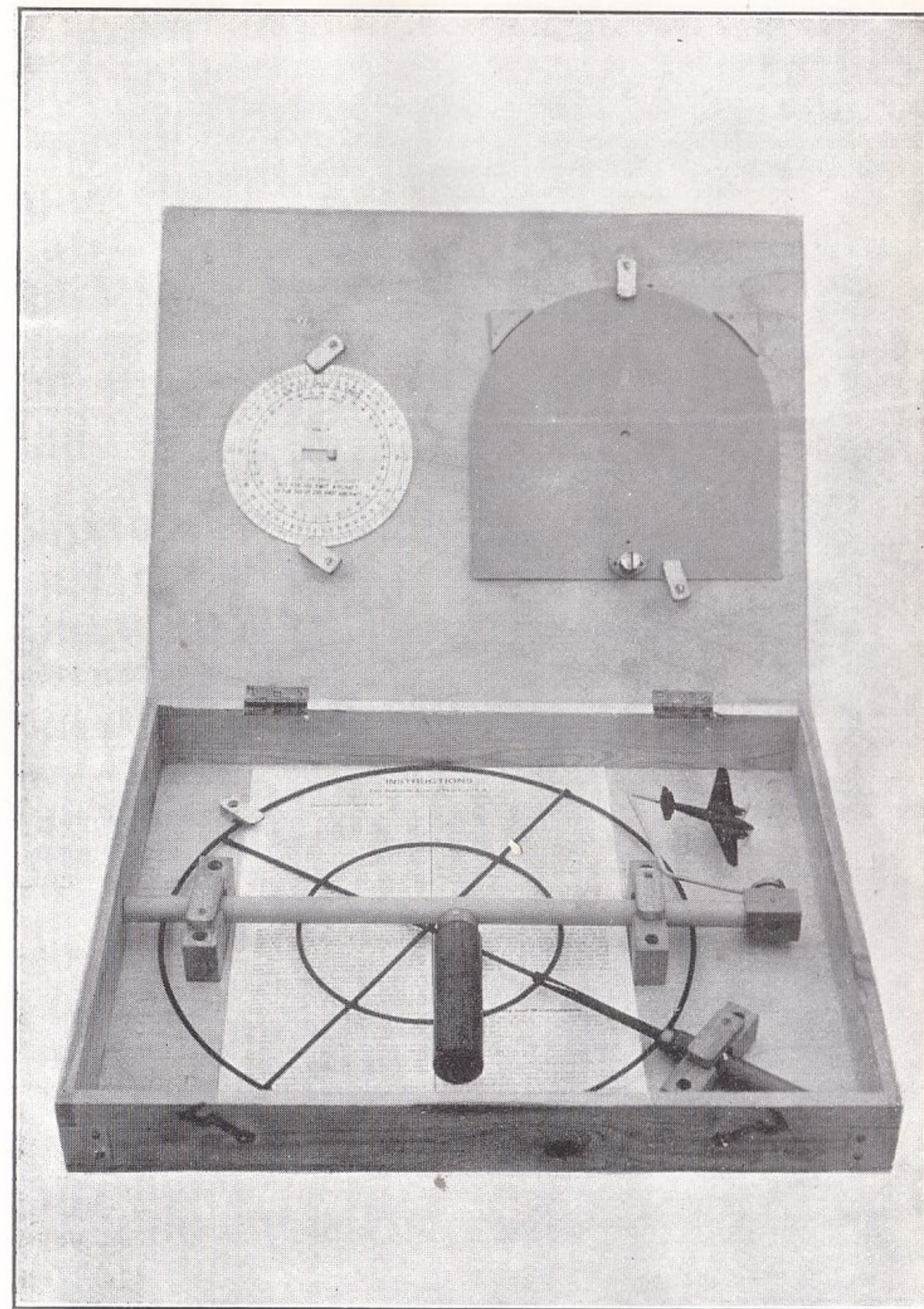


FIG. 17.—The portable aiming teacher (packed).  
To be issued to schools of instruction only.



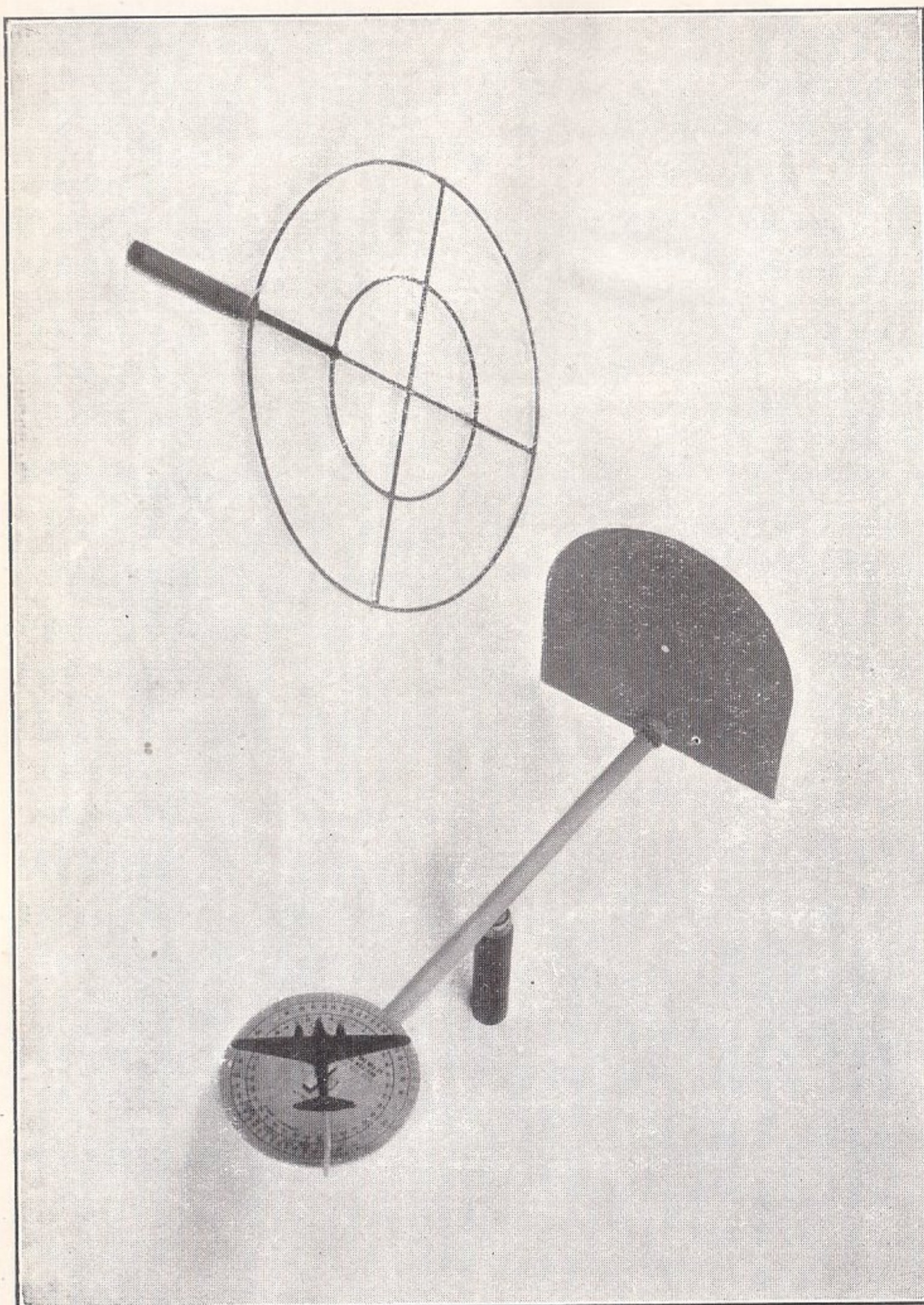


FIG. 18.—The portable aiming teacher and sight ring.  
(Assembled for instruction.)

4. Each man in turn looks at aim, instructor pointing out :—

- (a) Position of aircraft in sight (i.e. on 200 m.p.h. ring).
- (b) That X wires in eye-piece and cross-wires in cartwheel sight coincide.
- (c) That where wires cross is the correct future position of the aircraft.

5. As in para. 3 above, but for a 30-degree approach angle or half appearance view. Instructor will use flight bar and string to ensure direction is maintained. After laying the aim he will remove the string.

6. Each man looks as before.

7. Problems and practice with aircraft on a level keel at any approach angle or appearance view. Any speed group.

8. Instructor checks for amount by looking through the sight, and for direction by the use of the string.

9. Further problems and practice at all approach angles or appearance views, the aircraft climbing and diving but NOT banking. Any speed group.

10. Instructor checks as before.

11. Further practice, all speed groups and all approach angles or appearance views.

NOTE.—NO DIVE-BOMBERS.

### LESSON 3.

#### ESTIMATION OF AIM-OFF SPEEDS

*Kit required :—*

*Portable aiming teacher. (See Figs. 17 and 18.)*

*Blackboard and chalk.*

1. Recapitulate.
2. Explain kit, including sight ring, and how to use it.
3. Show correct aim for 200 m.p.h. aircraft, 90-degree approach angle or full appearance view (direct crosser).
4. Show correct aim for 300 m.p.h. aircraft, 30-degree approach angle or half appearance view.
5. Set problems at any approach angle or appearance view, and for any speed group.
6. Explain use of the five aim-off speed categories. (See Chap. I, Sec. 1, para. 3).



## LESSON 4.

## AIMING PRACTICE

*Kit required :—*

*Static aiming teacher (sight end only).*

*Fatigue man with model aircraft on pole.*

*Three circles or semi-circles of 9, 12 and 15 yards respectively.*

(NOTE FOR INSTRUCTORS.—Static aiming teacher will be at the centre of the circles with sights (master and pupil) converged at 12 yards. The fatigue man will move round the circumference of the 12 yards circle.)

1. Recapitulate on all previous lessons.
2. Explain the general lay-out and that the lesson is to give practice, against a moving target, in applying all the principles learnt so far.
3. Show each man a correct aim for a 90-degree approach angle or full appearance view (direct crosser). Instructor will tell each man the aircraft's speed group
4. Class practise with portable hand sights (if available).
5. Each man in turn lays a correct aim for a 90-degree approach angle or full appearance view, according to speed group given, instructor checking.
6. Further practice as necessary.

(NOTE FOR INSTRUCTORS.—For the second stage of this lesson, the fatigue man will move anywhere between the 9 and 15 yards circles as ordered by the instructor. He must at no time move outside these limits, as sight convergence will be affected if he does, thus giving the man under instruction an incorrect picture.)

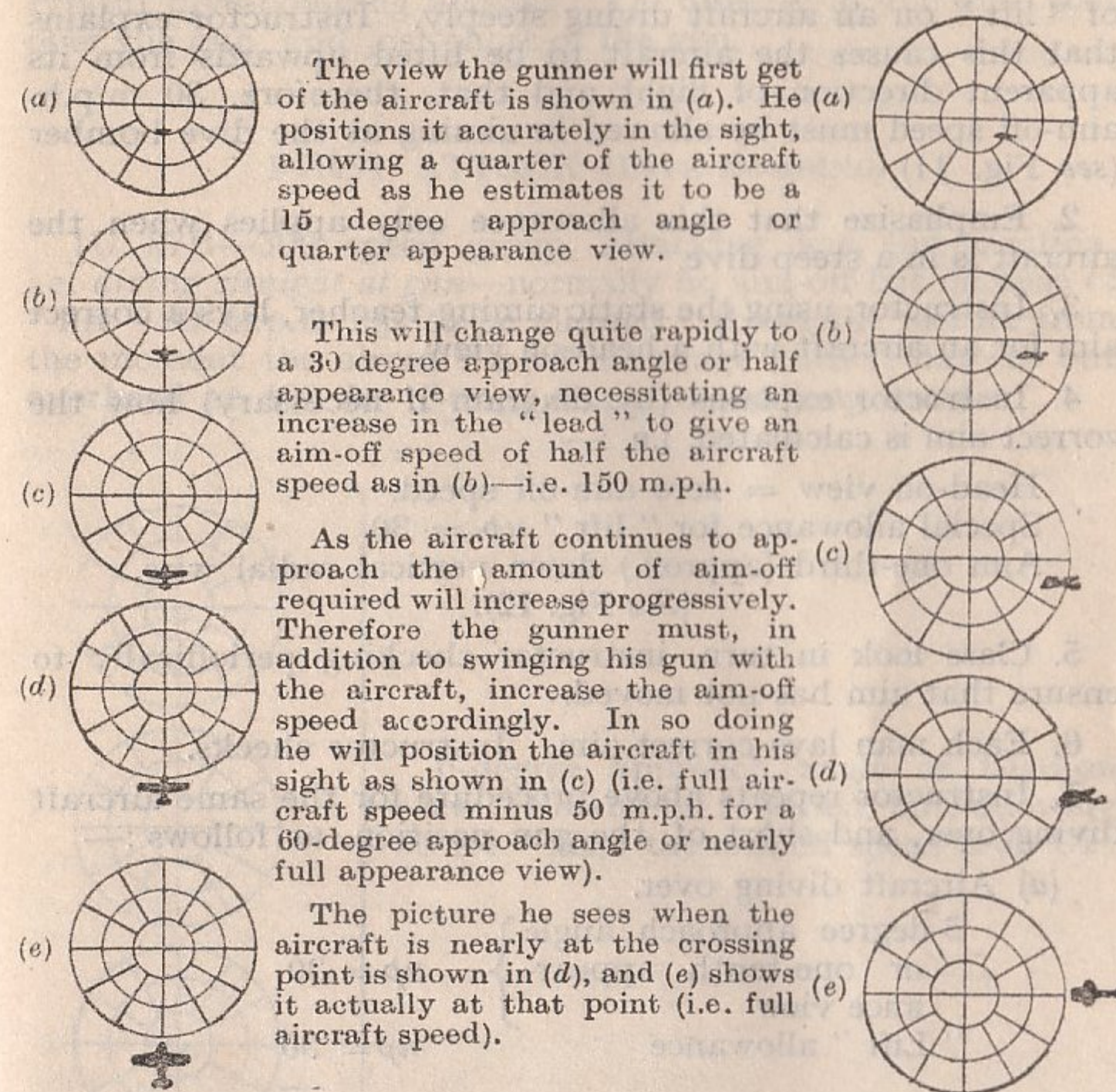
7. Instructor explains that further practice at different approach angles or appearance views will now be given.

8. Each man in turn acts as in para. 5, instructor checking.

NOTE.—Every advantage should be taken to practise against aircraft flying over the area, men using portable hand sights (if available).

## EXAMPLES

The pictures on either side show two typical types of attack—one approaching and one crossing target. Both aircraft are in the 300 m.p.h. speed group.



The view the gunner will first get of the aircraft is shown in (a). He positions it accurately in the sight, allowing a quarter of the aircraft speed as he estimates it to be a 15 degree approach angle or quarter appearance view.

This will change quite rapidly to a 30 degree approach angle or half appearance view, necessitating an increase in the "lead" to give an aim-off speed of half the aircraft speed as in (b)—i.e. 150 m.p.h.

As the aircraft continues to approach the amount of aim-off required will increase progressively. Therefore the gunner must, in addition to swinging his gun with the aircraft, increase the aim-off speed accordingly. In so doing he will position the aircraft in his sight as shown in (c) (i.e. full aircraft speed minus 50 m.p.h. for a 60-degree approach angle or nearly full appearance view).

The picture he sees when the aircraft is nearly at the crossing point is shown in (d), and (e) shows it actually at that point (i.e. full aircraft speed).

## LESSON 5 (OUTDOORS)

## DIVE-BOMBING

*Kit required :—*

*Static aiming teacher (sight end only).*

*Large-scale (one-eighteenth) model aircraft (JU. 87B or 88) on long pole set at a steep diving angle.*

*Blackboard and chalk.*

NOTES FOR INSTRUCTORS :—

(a) The distance of the static aiming teacher from the target will depend on the height of the pole. The different positions will be marked by pegs before the lesson.



(b) Figs. 12, 13 and 14 illustrate the method of applying the sight in the case of a 300 speed group aircraft diving. Diagrams on a blackboard similar to these will be found useful in teaching this lesson.

1. Recapitulate, with diagrams on blackboard, the effect of "lift" on an aircraft diving steeply. Instructor explains that this causes the aircraft to be lifted upwards from its apparent direction of flight and that, therefore, 30 m.p.h. aim-off speed must be allowed in aiming at the dive bomber (see Fig. 11).

2. Emphasize that this allowance only applies when the aircraft is in a steep dive.

3. Instructor, using the static aiming teacher, lays a correct aim for an aircraft with a head-on view.

4. Instructor explains (by diagram if necessary) how the correct aim is calculated, i.e. :—

Head-on view = zero aim-off speed.

Special allowance for "lift"  $up = 30$ .

Aim one-third (approx.) down vertical radial wire.

(See Fig. 12).

5. Class look in turn, instructor checking periodically to ensure that aim has not moved.

6. Each man lays correct aim. Instructor checks.

7. Instructor repeats above procedure for the same aircraft diving over, and short of, the gun position, as follows :—

(a) Aircraft diving over.

5-degree approach angle or one-tenth appearance view	}	$up = 30$
"Lift" allowance		

Actual allowance = 60

(See Fig. 13).

(b) Aircraft diving short.

5-degree approach angle or one-tenth appearance view	}	$down = 30$
"Lift" allowance		

$up = 30$

Actual allowance = NIL, i.e. a dead-beat shot.

(See Fig. 14).

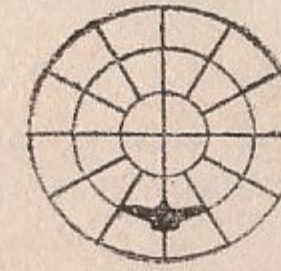
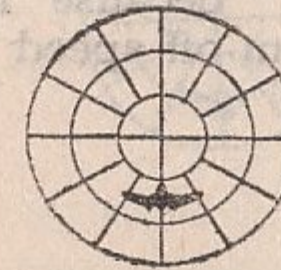
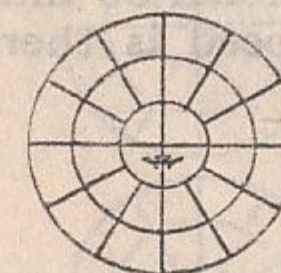
8. Class practise. Instructor checks.

## EXAMPLES

The following illustrations, given in a series of pictures (as seen through the cartwheel sight of the firer) show three typical dive-bombing attacks : i.e. directly at the gun, just over the gun, and just short of the gun.

### FIRST ATTACK (DIVE-BOMBING)

JU. 87B—300 speed group, attacking *own* gun position, i.e. *diving straight at gun*—normally no aim-off but because of "lift" 30 m.p.h. has to be allowed ; shows the picture from the moment the aircraft is within range until it flattens out overhead at 400 ft. Gun(s) firing in one long burst.



0-degree approach angle or head-on view. No aim-off required, but, allowing 30 for "lift," the aim-off speed is 30 UP.

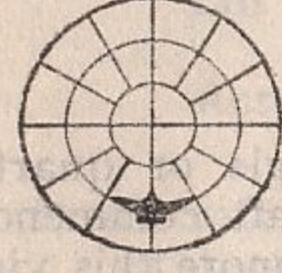
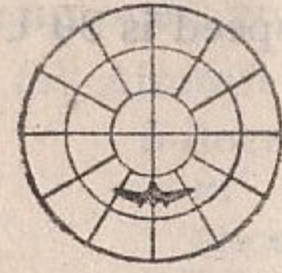
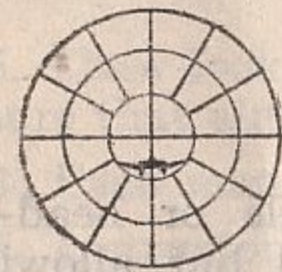
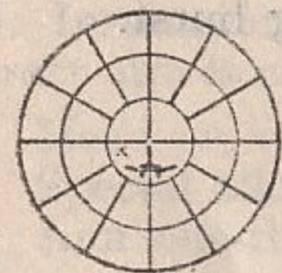
15-degree approach angle or quarter appearance view as aircraft commences to pull out of its dive. Ignore this view as it will very rapidly change to—

30-degree approach angle or half appearance view, so aim-off speed is one-half aircraft speed, i.e. 150—no allowance now for "lift" because aircraft has finished its dive, so total aim-off speed is 150.



## SECOND ATTACK (DIVE-BOMBING)

JU. 87B—300 speed group, attacking a post about 100 yards *behind* own gun position, i.e., *diving just over gun*—normally 30 m.p.h. aim-off speed would be correct, but because of "lift" an additional 30 m.p.h. has to be given; shows the picture from the moment the aircraft is within range until it flattens out overhead at 400 ft. Gun(s) firing in one long burst,



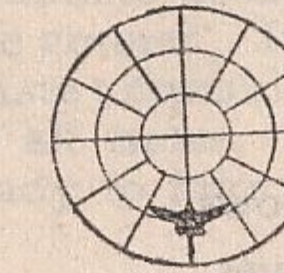
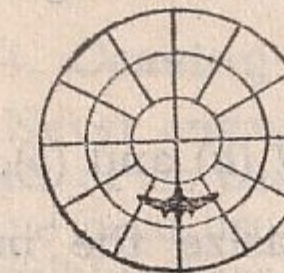
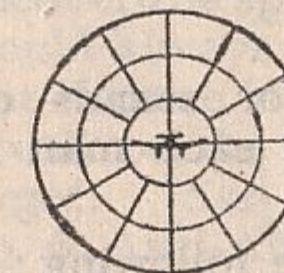
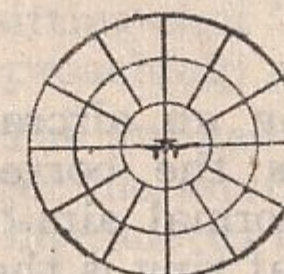
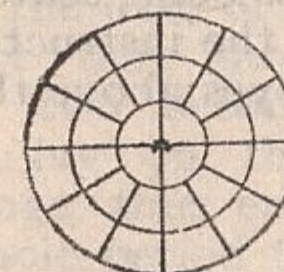
Diving over, so normally 30 m.p.h. aim-off speed *up* would be given, but because of "lift" an additional 30 must be added. Total aim-off speed is therefore 60 UP.

15 degree approach angle or quarter appearance view. Aircraft coming out of its dive. Ignore this view as it will very rapidly change to—

30-degree approach angle or half appearance view, so aim-off speed is one-half of aircraft speed, i.e. 150; no allowance now for "lift" because its dive is finished, so total aim-off speed is 150.

## THIRD ATTACK (DIVE BOMBING)

JU. 87B—300 speed group, attacking a post about 100 yards *in front* of own gun position, i.e. *diving just short of gun*—the allowance of 30 m.p.h. *down* for its one-tenth appearance view is cancelled out by the 30 m.p.h. *up* allowance for "lift"—*giving a dead-beat shot*. Gun(s) firing in one long burst.



Diving short, so normally 30 m.p.h. aim-off speed *down* would be given, which is cancelled out by 30 up allowance for "lift," making it a dead-beat shot.

15 degree approach angle or quarter appearance view. Aircraft coming out of its dive. Ignore this view as it will very rapidly change to—

30-degree approach angle or half appearance view, so aim-off speed is one-half of aircraft speed, i.e. 150; no allowance now for "lift," because its dive is finished, so total aim-off speed is 150.



## LESSON 6 (INDOORS)

*(Alternative to Lesson 5)***Kit required :—***Portable aiming teacher and sight ring.**Barrack table or suitable substitute.**Blackboard and chalk.***NOTES FOR INSTRUCTORS :—**

(a) The instructor stands on the table, the class being seated in front of him. The distance of the class from the instructor must be equal to the height of the instructor's eyes above the level of the table.

(b) See Note (b) to Lesson 5.

1. See Lesson 5, para. 1.

2. See Lesson 5, para. 2.

3. With diagram on blackboard representing an aircraft with a head-on view, instructor shows class the correct position for the sight ring. Point out that normal aim-off speed is applied first (in this case NIL), and that ring is then pushed up 30 to allow for "lift" (see Fig. 12).

4. Using portable aiming teacher, instructor stands on table and presents aircraft diving steeply, and each man in turn lays an aim, using the sight ring.

5. Instructor repeats above procedure for the following :—

(a) Aircraft diving over (see Fig. 13).

(b) Aircraft diving short (see Fig. 14).

For details of allowances see Lesson 5, para. 7 (a) and (b).

6. Further problems and practice. Emphasize the importance of speed.

**7. Fire discipline training**

1. Fire discipline may be summarized as follows :—

(a) Being ready for the enemy when he arrives.

(b) Opening fire at the correct moment at the right target.

(c) Ceasing fire at the correct moment to save ammunition.

**2. Being ready for the enemy**

It is imperative that gun detachments are, at all times, on the alert when they are on duty, so that vital moments will not be wasted when the order "Aircraft Action" is given. There must always be one member of the detachment on

look-out duty at the gun. The N.C.O. i.c. the detachment must always ensure that his gun(s) and ammunition are in perfect working order. When in action one man of the detachment must be detailed to look out for other targets.

**3. Opening fire at the correct moment at the right target**

Always wait for the target to come within range, i.e. 1,000 yards in the case of the 20 mm. gun and 600 yards in the case of smaller calibre weapons. Having in view the fact that target and bullet will have travelled for one or two seconds before they meet, it will be possible to lay on the target when it is just beyond effective range, thus ensuring that it is engaged with fire during the whole period that it is within range. The target presents a "sitting-shot" when it is flying on a level course (directly approaching) and this is the best moment to fire.

The gunner must act instantly and instinctively if he is to "get his aircraft" while it is within effective range. There is no time to refer to notes or to charts in action in order to discover the speed group of an aircraft and its nationality. He should always take on the aircraft which looks like attacking first if there is more than one. If he cannot decide which one it will be, he must select the one that presents the easiest target. (See Small Arms Training, Volume I, Pamphlet No. 6, Anti-Aircraft, 1942, Section 8.)

**4. Ceasing fire at the correct moment**

Never engage any target once it is out of range. There is little or no chance of hitting it, and ammunition which might have been used effectively against another easier target is not available because of careless and unnecessary expenditure by the gunner. In the heat of action it is a very simple matter to waste ammunition, and this tendency must be guarded against at all times. Always remember "the next target," and be ready to take it on.



# APPENDIX A IMPROVISED TRAINING KIT

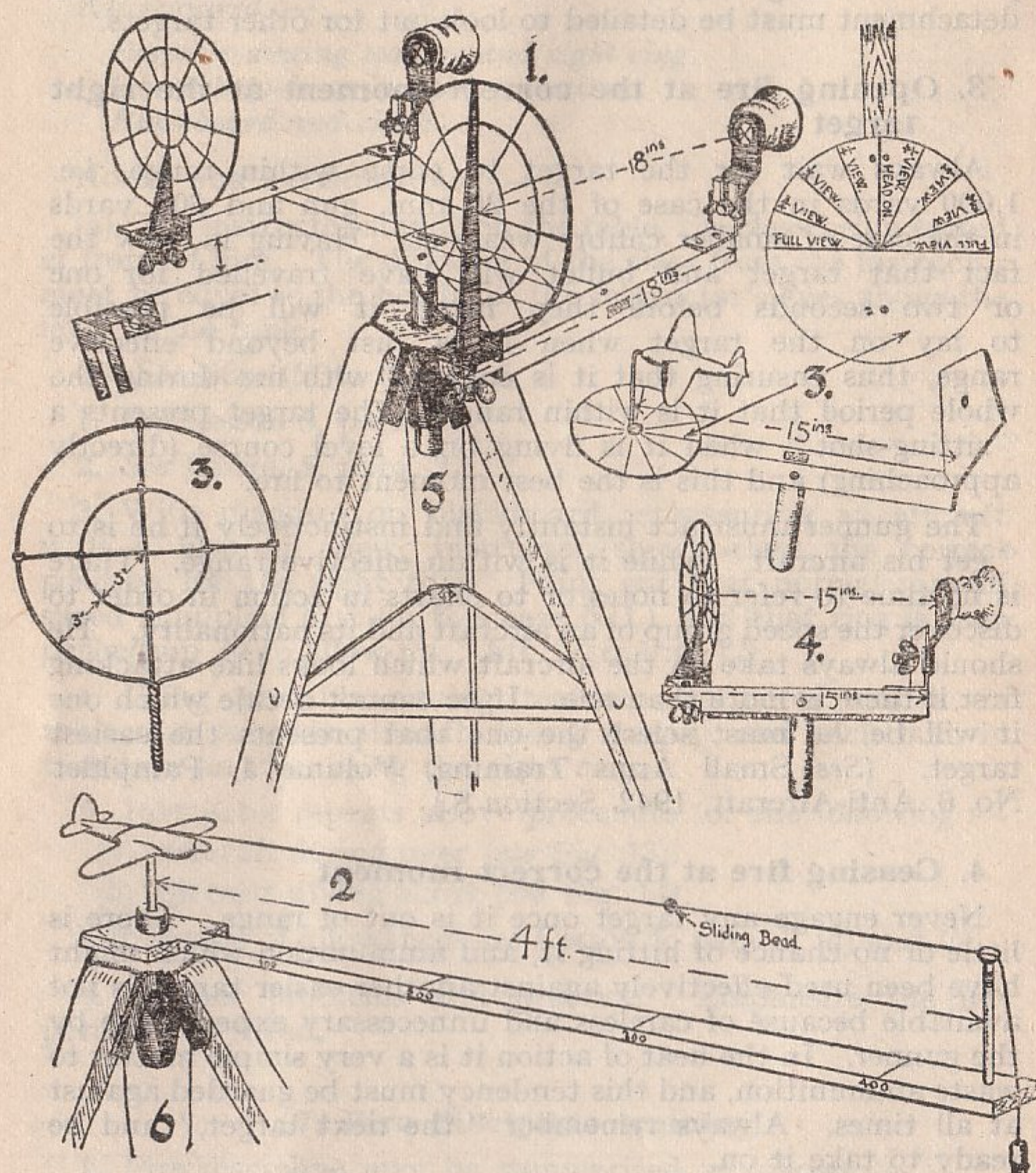


FIG. 19

## Legend

- |   |                              |
|---|------------------------------|
| 1. Static aiming teacher (sight end).             | 4. Portable hand sight.      |
| 2. Static aiming teacher (target end).            | 5. } Aiming rests less rifle |
| 3. Portable aiming teacher, including sight ring. | 6. } holder.                 |

## NOTES

i. All the above are very simple to make and can easily be constructed by unit pioneers.

ii. If aiming rests are not available, earth walls or a pile of filled sandbags can be used.

iii. Kits Nos. 1 and 4 take the issue standard aperture back-sight and cartwheel sight.

iv. Only one dimension on each article has been given. The remainder of the piece is proportional.

v. Since this publication went to Press, it has been decided to abolish the "Flight Table" in lesson 2. The necessity for a sliding bead and the sub-divisions on the flight bar, as shown in diagram 2, does not therefore arise.



## APPENDIX B

## SPEED GROUPS OF ENEMY AIRCRAFT

## Fast group—300 m.p.h.

- (G) Me. 109 E.
- (G) Me. 109 F.
- (G) F.W. 190.
- (G) Me. 110.
- (I) Macchi 202.
- (G) Ju. 88.
- (G) Ju. 87 B (when diving).
- (I) Fiat G.50.
- (I) Reggiane 2001.
- (G) Me. 210.
- (G) Do. 217 E.2.
- (J) Mitsubishi S "oo" (Navy)

## Medium group—200 m.p.h.

- (I) C.A.N.T. Z 1007.
- (I) Caproni 135.
- (I) Savoia Marchetti 79.
- (I) Fiat C.R. 42.
- (G) Do. 17Z.
- (G) F.W. 200 Kurier.
- (I) Piaggio 108.
- (G) Ju. 87 B.
- (I) Fiat B.R. 20.
- (I) C.A.N.T. Z 506.
- (G) Henschel 126.
- (G) Henschel 129.
- (G) Ju. 90.
- (J) Mitsubishi T.97.
- (G) Do. 24.
- (G) Do. 26.
- (G) He. 111.
- (G) He. 177.
- (G) F.W. 189.

## Slow group—100 m.p.h.

- (G) Ju. 52.
- (G) Fieseler (Storch) 156.
- (J) Nakajima T.96.
- (G) Do. 18K.

(G) German.      (I) Italian.      (J) Japanese.





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